Space Weather Technical Forecast

Issued on Tuesday 5 November 2024 at 13:29 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Moderate to High solar activity with further M-flares expected, and a slight chance of X-class flares. Chance of G1/Minor Storms on 06/07 Oct.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has increased to High levels due to occasional M-class flare activity. The largest flare was an M5.5 event at 04/1538 UTC from AR3883 in the southeast disc. There are twelve active sunspot regions visible on the solar disc, including three unnumbered regions. In the southeast, AR3883 has generated multiple M-class solar flares and features at least one delta spot, with slight growth and separation evident in the group during the period. Growth was observed in the moderately sized region AR3886 as it rotated into clearer view in the southeast. AR3878 in the northwest continued to decay, with the loss of its delta spot. The remaining spots on the disc are comparatively smaller or less magnetically complex. New minor spots emerged in the southeast and northwest disc, meanwhile AR3869 rotated off the facing-disc.

A CME that left the Sun on 04 Nov following the M5.5 flare of AR3883 is awaiting additional modelling to determine if there is an Earth-directed component, although the bulk of the ejecta appears to be directed behind Earth orbit.

Solar Wind / Geomagnetic Activity: Solar winds as measured at L1 by ACE/DSCOVR were at Slightly Elevated levels throughout, generally between 420-470km/s owing to minor coronal hole influence. Density was predominantly below average. The Interplanetary Magnetic Field (IMF), Bt, was predominantly Weak, around 5-8nT, but increased to Moderate late in the period (peak 10nT). The north-south component, Bz, varied weakly, oscillating between positive and negative directions. Phi angle was persistently positive (away from the Sun). Geomagnetic Activity was Quiet to Unsettled (Kp0-3).

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 fell to background levels through the period. High energy electron flux (greater than 2MeV) observed by GOES16 was at background. The associated 24-hour fluence was well below the Active threshold, with 1.56e6 integrated flux observed at 05/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High activity is forecast to continue, with occasional M-class flares expected and a slight chance of isolated X-class flares. These most likely from AR3878, AR3883 and AR3886.

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Solar Wind / Geomagnetic Activity: Connection to coronal hole fast winds is ongoing, albeit weakly, with the enhancement expected to continue until Day 2 (06 Nov). A further minor HSS enhancement is possible late Day 4 (08 Nov).

A CME that left the Sun early on 04 Nov is being reanalysed, but may give Earth a glancing impact either on Day 2 or 3 (06 or 07 Nov) with low-moderate confidence.

Generally Quiet to Unsettled geomagnetic activity is forecast on Day 1 (05 Nov), with a chance of isolated Active intervals at first. Activity is then expected to decline to mainly Quiet levels through Day 2 (06 Nov) and Day 3 (07 Nov), potentially becoming Unsettled to Active with a chance of G1/Minor Storm intervals depending on any potential CME influence. On Day 4 (08 Nov) activity should be Quiet to Unsettled, but with a chance of isolated Active intervals.

Energetic Particles / Solar Radiation: The high energy proton flux at GOES-18 has now declined to background levels, with only a slight chance of any further enhancement above S1/Minor Storm levels. The high energy electron flux is expected to be mainly Background to Moderate, with the associated fluence forecast to persist below Active levels.

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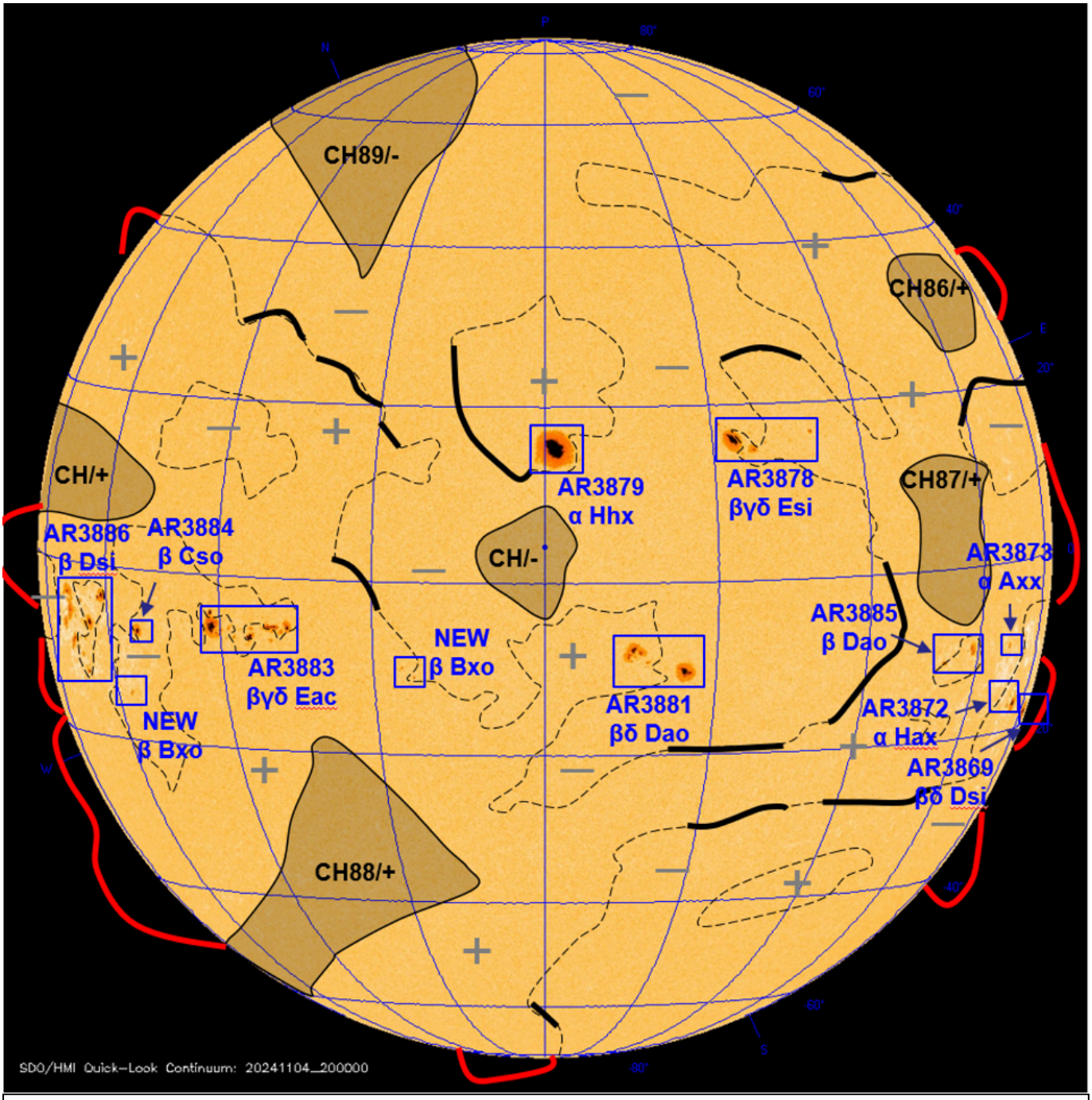
Figure 1: Solar Synoptic Map valid 04/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

A CME was observed off the E limb in association with the M3.8 flare from AR3883 at 04/0141UTC, with an associated Type II radio emission of 307km/s. Some data gaps in coronagraph imagery have backfilled since the initial analysis was conducted by MOSWOC. Although the bulk of the ejecta appears to pass behind Earth's orbit, a faint partial halo of material (mainly shock) appears to pass the Earth-Sun line, meaning that there is an increased chance of a glancing impact from this feature either on 06 or 07 Nov than previously indicated. Further analysis is ongoing into this event that currently carries low-moderate confidence.

An additional CME that left the Sun later on 04 Nov following the M5.5 flare of AR3883 is awaiting additional modelling to determine if there is an Earth-directed component.

The near Earth environment continues to be weakly enhanced with winds currently at Slightly Elevated levels, likely as a result of a weak connection to coronal hole CH87/+, or perhaps CH86/+. A stronger connection cannot be ruled out, perhaps raising solar winds to Elevated levels Day 1 (05 Nov). An unnumbered coronal hole near centre disc may also give an enhancement in solar winds later on day 4 (08 Nov) or on 09 Nov, but as this is a non-recurrent feature confidence is moderate. MOSWOC's ENLIL model shows significant speed increases from HSS influence from day 3 (07 Nov), but this appears to be unreliable.

Generally Quiet to Unsettled geomagnetic activity is forecast on Day 1 (05 Nov), with a chance of isolated Active intervals at first. Activity is then expected to decline to mainly Quiet levels through Day 2 (06 Nov) and Day 3 (07 Nov), potentially becoming Unsettled to Active with a chance of G1/Minor Storm intervals depending on any potential CME influence. On Day 4 (08 Nov) activity should be Quiet to Unsettled, but with a chance of isolated Active intervals.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	30	30	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
2024-11-04 05:39	Partial	AR3883	SE	880	06-07 Nov	Arrival time still uncertain as CME awaiting further analysis and modelling.

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Radio Blackouts - X-Ray Flares

There are twelve active sunspot regions on the visible disc, including three unnumbered regions. The largest flare of the period was an M5.5 flare of AR3883 at 04/1538 UTC. Solar Activity is currently High due to occasional M-class flare activity.

In the southeast, AR3883 has generated multiple M-class solar flares in the past 24-hours and contains at least one delta spot in the interior of the group. Slow growth is apparent and consolidation of the leading and intermediate region is evident. AR3886, also in the southeast, continues to rotate into clearer view. It is a moderately sized region with a large number of spots and slow growth, but the spots occupying the intermediate portion of the group are still fairly well separated at this time with limited magnetic shearing. Previously active AR3878 in the northwest continues to slowly decay. It has lost its small delta spot, with most of its intermediate spots now faded.

The cluster of spots in the southwest are approaching the limb and as such are difficult to analyse. These regions will rotate over the western horizon in the coming days. The other spots on the disc are comparatively smaller or less magnetically complex. A region at or just beyond the eastern limb produced an M2.6 flare at 05/0654 UTC. As it rotates onto the facing-disc in the coming days this could supplement existing flare probabilities and offset the loss of the regions in the southwest.

Moderate or High Solar activity is forecast to continue, with further M-class flares expected and a slight chance of isolated X-class flares, with AR3878, AR3883 and AR3886 currently the most likely source for significant flares.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	80	80	80	80
Very Active	R3-R5 (X Class)	No	15	15	15	15

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Figure 2: SDO/AIA 94 imagery at 05/1255 UTC.

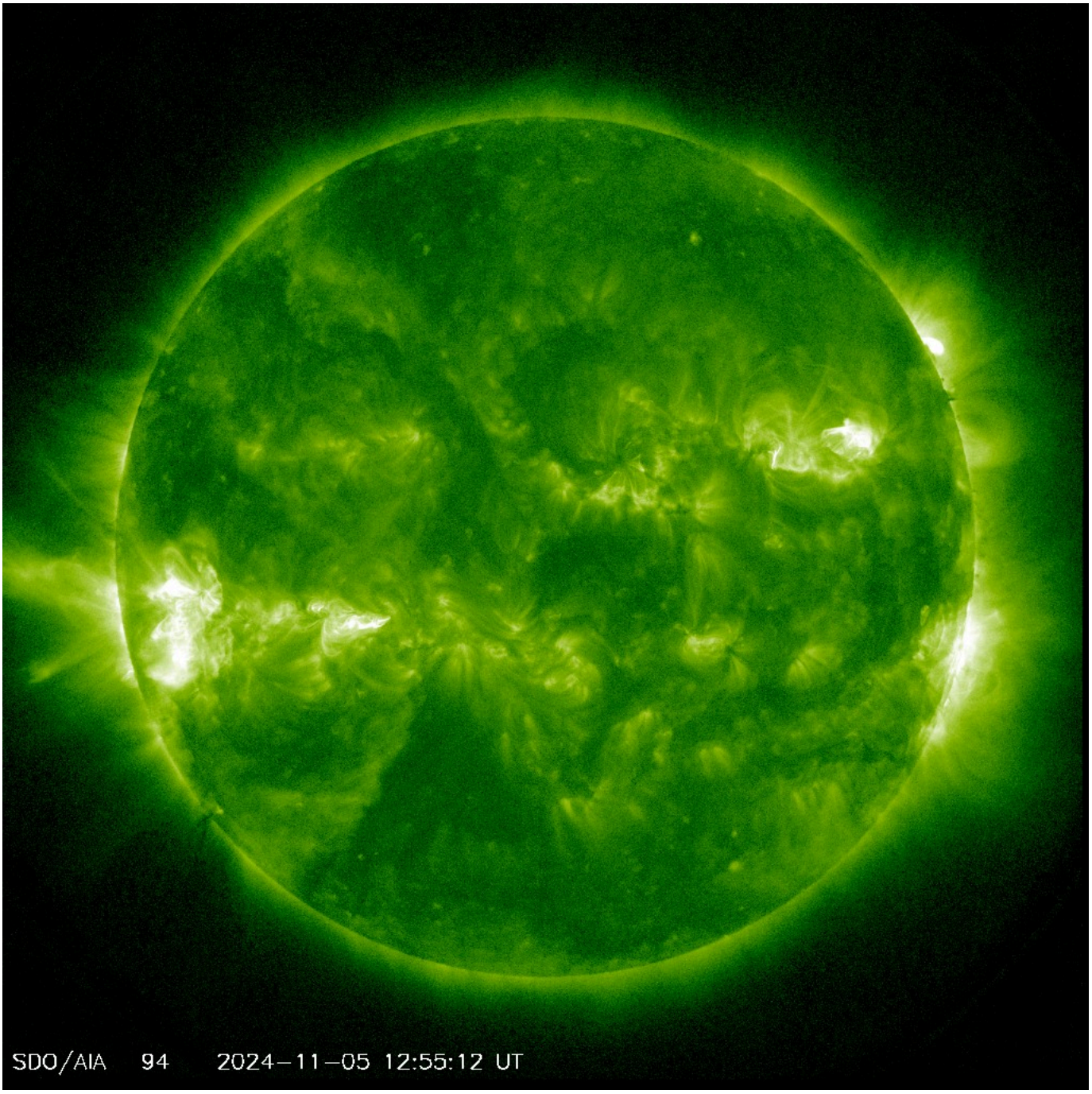

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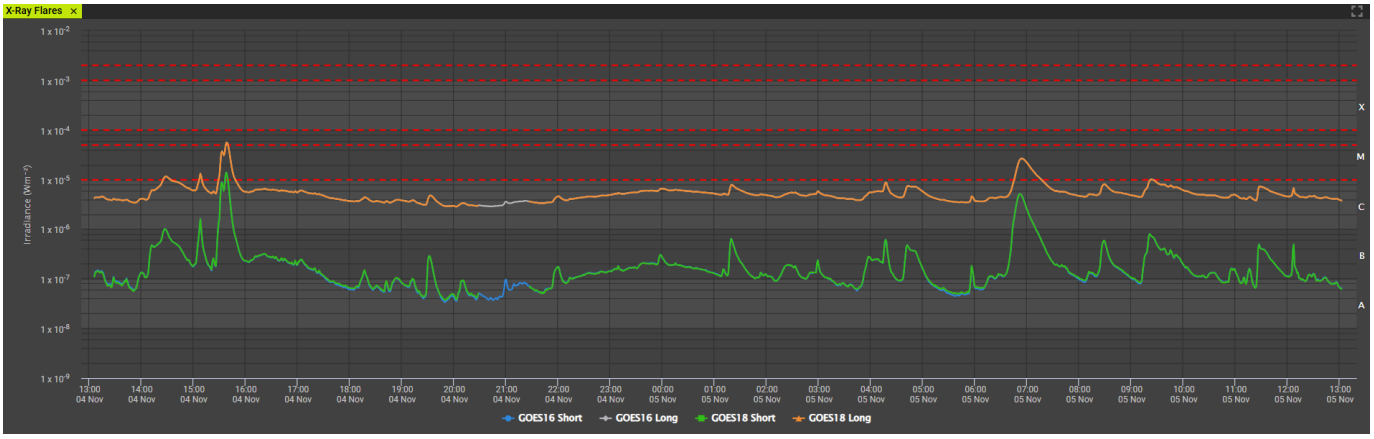
Figure 3: Latest GOES16/18 X-Ray Flux trace



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Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES-18 has returned to normal background levels following recent enhancements.

Many of the sunspots that occupy the usually more geoeffective western hemisphere are smaller, less complex regions compared to those in the eastern disc, however, a number of regions recently rotated over the western horizon could still pose a small risk of an enhancement in the next couple of days.

There is a slight chance of S1/Minor Proton Storms or greater during the period should any further proton-rich flares occur.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	10	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

High energy electron flux (greater than 2MeV) as observed by GOES16 is currently at background and expected to persist mostly at this level, with only brief periods of Moderate enhancement expected. A more significant connection to coronal hole fast winds than we are currently seeing could see the electron belts charged up over the next couple of days, with the belts then expanding later in the period, and electron flux levels rising perhaps to more Moderate to High levels.

The associated 24-hour fluence is currently expected to remain well below Active throughout the period however, with the MOSWOC REFM forecast thought to be providing reasonable guidance.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	5
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

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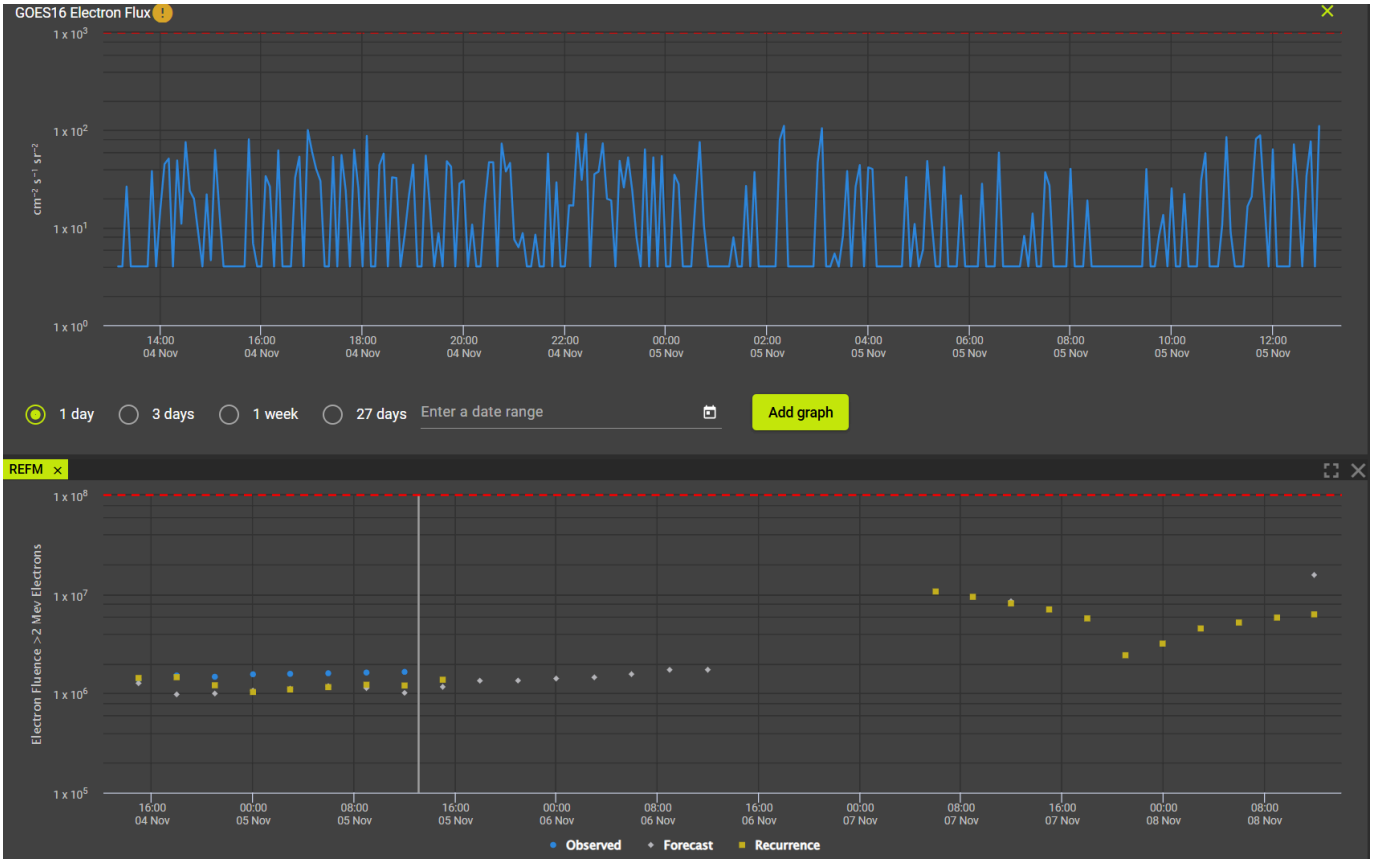
Figure 4: Latest GOES16 >2MeV Electron Flux trace (above) and MOSWOC REFM forecast and Recurrence (below).



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